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Death by "Snow"! A Fatal Forensic Case of Cocaine Leakage in a "Drug Mule" on Postmortem Computed and Magnetic Resonance Tomography Compared With Autopsy

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Abstract: This forensic case presents unique postmortem imaging of a "drug mule" with fatal intoxication due to cocaine leakage on postmortem computed and magnetic resonance (MR) tomography compared with autopsy.

Imaging by postmortem computed and MR tomography was performed before autopsy, histology, and toxicology were commissioned. Forensic imaging revealed 91 hyperdense, uniformly shaped body packs with signs of leakage, which was confirmed by autopsy. Postmortem MR imaging displayed the rarely described hypointense appearance of the body packs in T1- and T2-weighted sequences. Toxicology stated the dosage of cocaine intoxication as lethal.

This case provides an opportunity to image internal cocaine drug containers on postmortem computed and MR tomography. The cause of death could be determined based on imaging and the radiological morphology of these packs by both imaging methods.

Key Words: Virtopsy, Body packing, drug mule, cocaine, forensic radiology, postmortem magnetic resonance imaging

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Drug smuggling is a global problem.[1] Major payloads (multiple kilograms) of illicit drugs are smuggled by ship, over land, or by airplane into the destination country. According to the latest joint annual report by the European Monitoring Centre for Drugs and Drug Addiction and Europol, there is a notable diversification in trafficking.[2] Drugs are moved through multiple transit points and complex channels, and the use of legitimate commercial transport is increasing.[2] In situations of an urgent demand on the market, drug couriers can deliver smaller payloads quickly through other smuggling channels. Hence, there is an increasing need for the radiological detection of intracorporal illicit drugs, such as cocaine, heroin, opium, (met-) amphetamine, and cannabis.[3–5]

The major illicit drug that is smuggled into Switzerland is cocaine, followed by heroin. In Southeast Asia, (met-) amphetamine is predominant.[4,6] The slang term "drug mule" describes a drug courier who is employed to carry illicit drugs across borders.

The customary usage of the term "body packer" for drug carriers includes all methods of smuggling within the gastrointestinal tract. More specifically, drug carriers with hidden packs within the alimentary tract can be categorized into 1 of 3 groups[3,5]: (1) Body packers swallow a large number of drug packets (typically more than 100 packs), each with an approximate weight between 10 and 12 g, for transportation across borders.[3,5,7,8] These drugs, hidden in the alimentary tract, typically feature a high degree of purity (eg, cocaine from South America is 70% to 80% pure, whereas that from the Dominican Republic, approximately 50% to 60%). Therefore, leakages of even tiniest amounts of the substance are highly toxic and pose a danger to life.[4,8–13] This method of intracorporal smuggling is typically organized by drug cartels and serves the purpose of distribution within the destination country. (2) Body pushers hide drug containers within natural orifices, such as the rectum or vagina.[3,5,9] These packs are typically very large and are detectable by manual examination. Body pushing occurs often in combination with body packing to smuggle larger amounts of the illicit drug across the border or simply hide the drug from competing drug dealers, from round ups by the authorities or corrections officer or from fellow inmates in prison (the rectum is called the "prison pocket" within the drug milieu and in prison). Body pushing may be simply an incidental finding; it is not necessarily the cause of death or lead directly to hospital admittance. (3) Body stuffers are commonly drug dealers who sell an already cut substance with a low degree of purity on the street. The drug pellets for sale can be quickly swallowed in the case of a sweep by the police or custom officers.[5,9–12] These pellets are quite small (typically between 0.5 and 2 g) and are often more sloppily wrapped than are the mechanically made body packs. However, the pellet, although they contain a lower-purity substance, are still toxic.[3,14]

This forensic case presents unique postmortem imaging of a drug mule with fatal intoxication due to cocaine leakage on postmortem computed and magnetic resonance (MR) tomography compared with autopsy.

MATERIALS AND METHODS

Case History

A 45-year-old, obese, Caucasian male was found dead lying on his left side on the pavement of a dead-end street.

External Inspection

External inspection revealed signs of decomposition and livores that did not match the position in which the body was found. Based on the localization of the outer livores, the body lay in the prone position for some hours after death and was later moved into the final position in which it was found. The body exhibited no defensive injuries.

Postmortem Imaging

Postmortem Computed Tomography

The responsible justice department approved imaging and mandated a forensic autopsy. The corpse received a standardized

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full-body postmortem computed tomography (PMCT) scan using a dual-source 128-slice scanner (SOMATOM Flash Definition, Siemens Healthcare, Forchheim, Germany) at 120 kVp tube voltage with automated dose modulation using the parameters based on the literature.[15] Reconstructions were made in a soft tissue window with a soft kernel and bone window or lung window with a hard kernel.

Postmortem MR Imaging

Postmortem MR (PMMR) imaging was performed using a 3.0-tesla MR imaging unit (Achieva TX, Philips, Best, The Netherlands) after the case was scanned by PMCT. The evaluated case underwent a standard thorax and abdomen protocol using a body coil that included T1-weighted (T1w, fast field echo), T2-weighted [T2w, turbo spin echo (TSE)], and T2-weighted fat saturated steady state inversion recovery (STIR) sequences in axial and coronal orientation (5 mm).[16] The parameters were set as follows: T1w, TR 254.4 to 625.0 and TE 2.3 to 7.1; T2w, TR 3581.5 to 3753.3 and TE 76.0 to 100; STIR, TR 6008.9 to 10,325.3 and TE 60 to 70. The axial field of view was 521×521, and the coronal was 1035×471.

Image Review

Primary image review and 3-dimensional reconstructions were performed using a CT workstation (Syngo MM WP, Siemens Healthcare, Forchheim, Germany). For radiological assessment, a multimodality workstation was used (Syngo via, Version VB10A, Siemens, Medical Solutions, Erlangen, Germany). Specific image reconstructions were additionally performed using cinematic rendering in a physics-based visualization software package (Research Platform, Cinematic Rendering, Siemens CT 1.0.0, Frontier Prototype Store, Syngo via, Version VB10A, Siemens, Medical Solutions, Erlangen, Germany). Radiological analysis and reporting were performed by a board-certified radiologist with forensic experience.

Autopsy

The conventional autopsies included dissections of the 3 body cavities (skull, thorax, and abdomen) and the neck. Autopsy was performed by a board-certified forensic pathologist and a resident.

Histology

Histology was taken from the myocardium, left anterior descending (LAD) coronary, lung, brain, galea, and musculature. Staining included hematoxylin-eosin stain and Verhoeff elastic stain of the heart, coronary (LAD), and the lungs. The cerebellum was stained by hematoxylin-eosin and galea. Hematoxylin-eosin and iron stain were used for the musculature.

Toxicology

Toxicology was performed as mandated by the legal authorities.

RESULTS

Postmortem Imaging

Imaging revealed progressive signs of decomposition with gas within the body cavities and soft tissue, organs, and vasculature (Figs. 1 and 2). The brain exhibited potential brain edema, but the diagnosis was impaired by putrefaction. Typical decompositional changes of the lung with pleural effusion and relapse of both lungs and tissue changes were observed. Despite these changes, signs of aspiration were visible. Pulmonary edema was probable but was not truly assessable. The heart was enlarged as far as assessable, and coronary sclerosis was present.

The entire gastrointestinal tract from the stomach to the sigmoid colon was filled with 91 hyperdense, uniformly shaped body packs [length, 4.3–4.6 cm; diameter, 1.7 cm; estimated to have a volume of approximately 6 to 7 g, Hounsfield unit (HU) 175–290] (Figs. 1 and 2). Some of the packs exhibited a slightly lower attenuation (approximately 130 HU). The packs exhibited a “pseudo-linguini-sign” that was similar to the linguini sign described for the intracapsular rupture of silicone breast implants, which in this case corresponded to the wrapping and mechanical manufacture of the packs (Fig. 3).[17] At least 1 pack was located in the stomach, and 4 of the packs found in the colon displayed an accumulation of intraluminal

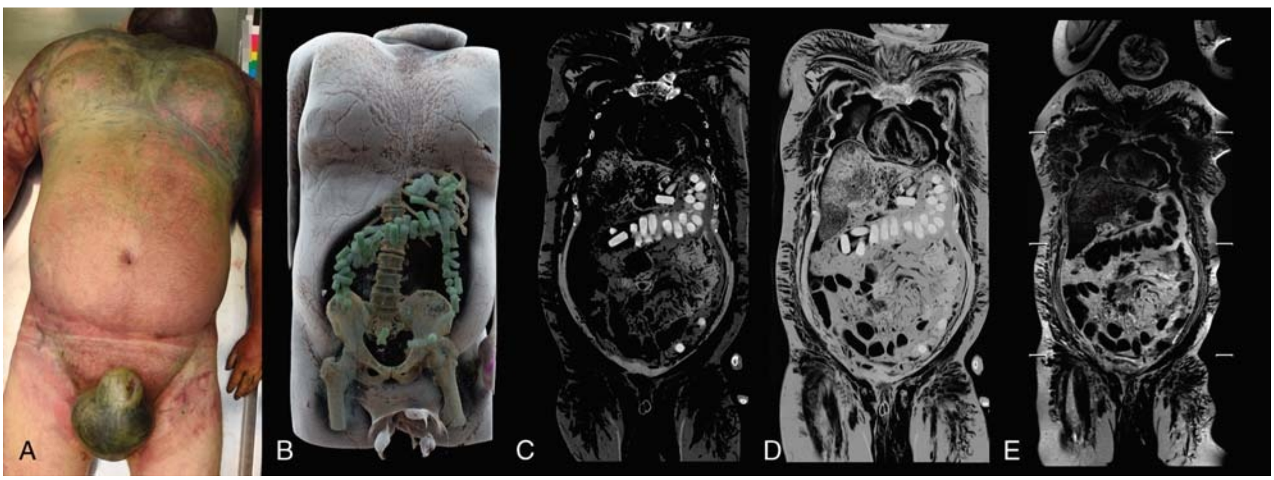

FIGURE 1. A, Photograph of the body with external signs of decomposition. B, Cinematic rendering technique showing the extent of decomposition with a gas-filled superficial vasculature, a bloated scrotum, and gas within the soft tissue. The ingested packs are colored in green and are distributed along the stomach. One pack is located in the ileum, and most of the packs are located within the colon. C, PMCT in a hard kernel with bone window (coronal view). The packs appear hyperdense to less hyperdense and align within the gastrointestinal tract. D, PMCT in a hard kernel with an adjusted lung window (coronal view). Note the vast signs of decomposition with gas within the organs, vasculature, and the soft tissue. E, T2w PMMR showing the hypointense body packs in a coronal view similar to PMCT (C and D). Figure 1 can be viewed online in color at www.amjforensicmedicine.com.

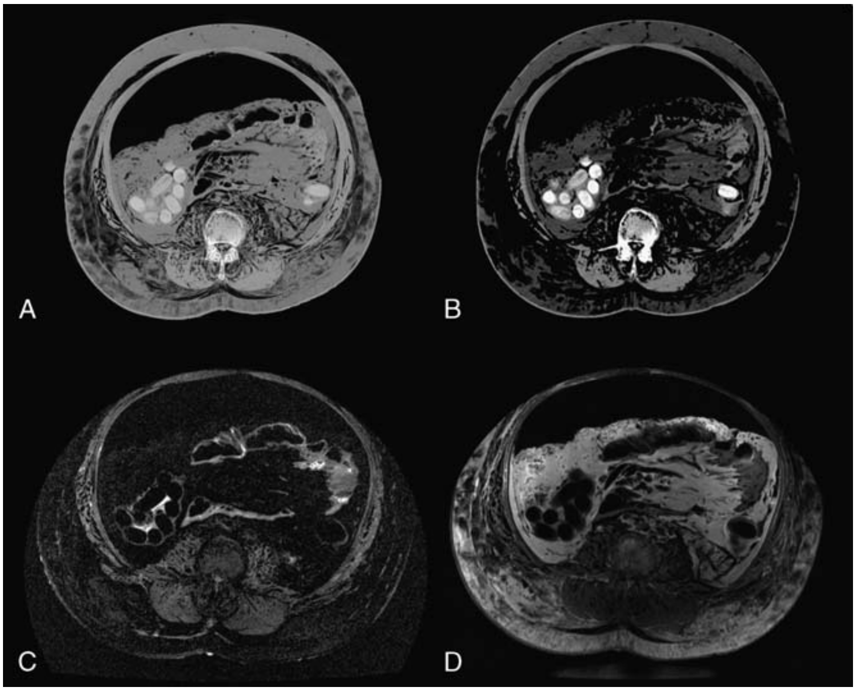

FIGURE 2. A, PMCT in a hard kernel with an adjusted lung window. Pneumoperitoneum due to decomposition and putrefactive gas within the soft tissue and organs. The internal packs appear hyperdense. B, PMCT in a soft kernel with abdominal window at the same level as A. C, PMMR, STIR TSE sequence at the same level as the axial PMCT images (A, B). The internal packs appear homogenously hypointense, similar to intra-abdominal gas. D, PMMR, T1w TSE sequence with the same hypointense appearance of the internal packs as in T2w images at the same level as A–C.

gas and little fluid within the pack, with slightly hypodense measurements (HU 120–200), which suggested leakage of the substance inside (Fig. 3).

Postmortem MR was impaired by the decompositional gas, and a hypointense signal of the internal packs was noted in all 3 sequences (T1w, T2w, and STIR) (Figs. 1 and 2).[18] The STIR sequence was useful for detecting fluid accumulation but not for morphology or diagnosis (Fig. 2). In this decomposed case, T2w and T1w sequences (in that order) were superior to the STIR sequence (Figs. 1 and 2).

As the cause of death, imaging established intoxication with central regulatory failure due to leakage of the ingested body packs.

Autopsy

Autopsy confirmed the imaging findings of 91 gastrointestinal drug containers. Fifteen were located in the stomach, 1 in the ileum, and 75 in the colon (Figs. 4 and 5). The intestines were dilated. Edema of the brain and lungs was visible despite decomposition. The heart was enlarged (43% according to Zeek), with thickening

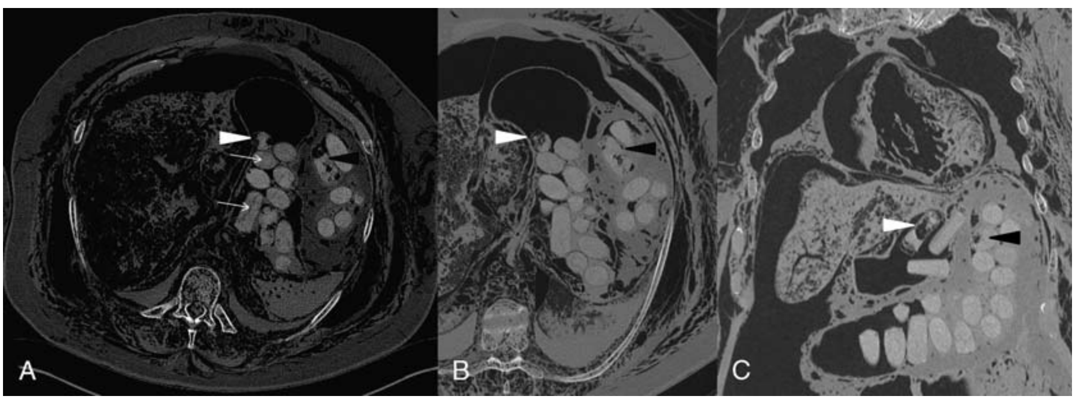

FIGURE 3. A, Axial slice in a hard kernel and bone window. The packs either imaged transverse or longitudinal exhibited a "pseudo-linguini-sign" delineating the wrapping structures with inevitable air inclusions inside the packs (white arrows, exemplarily). Packs with gas and fluid intrusion due to leakage (white arrowhead, located in the stomach; black arrowhead, located in the colon). B, Magnified view of an axial slice at the level of the stomach and left colon flexure displaying packs with gas and fluid intrusion due to leakage (white arrowhead, located in the stomach; black arrowhead, located in the colon). C, A detailed view in an angulated coronal plane displaying the same packs with gas and fluid intrusion due to leakage shown in A and B (white arrowhead, located in the stomach; black arrowhead, located in the colon).

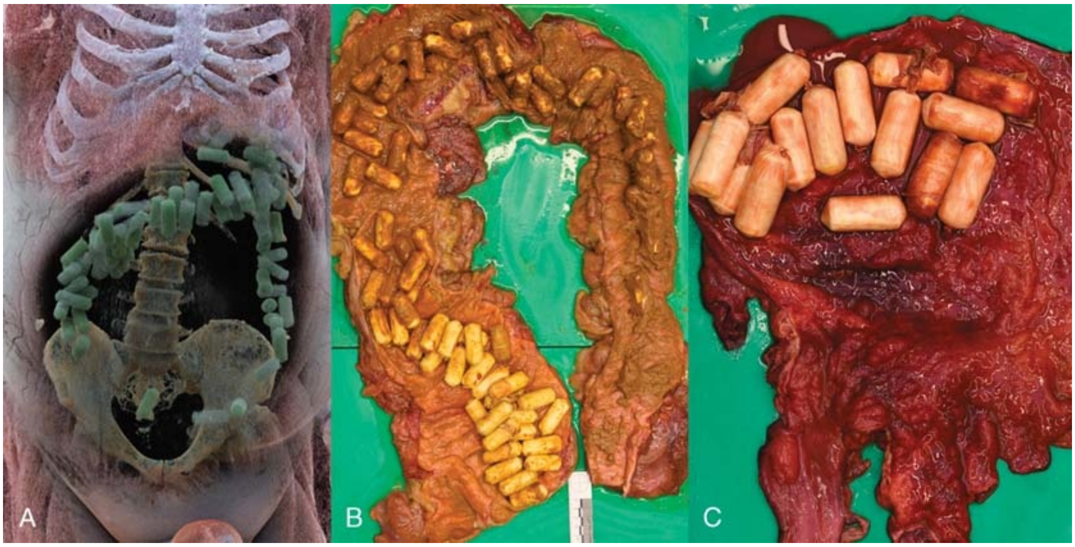

FIGURE 4. A, Cinematic rendering technique displaying bony structures, soft tissue, and the internal packs on 1 image with an easy and quick overview of the distribution of the cocaine packs within the alimentary tract. B, Autopsy photograph of the colon with the packs aligned along the intestines. C, Autopsy specimen of the stomach. Note the loose wrapping material (plastic foil) and the discoloration of the disintegrated cocaine packs. Figure 4 can be viewed online in color at www.amjforensicmedicine.com.

of the left cardiac ventricular wall.[19] Generalized arteriosclerosis was detected. The body exhibited a condition after surgical removal of the gall bladder and appendix. Body mass index was 36.6 kg/m^2. Combined with toxicology, the cause of death was confirmed as intoxication by cocaine with central regulatory failure in a case of fatal body packing.

Histology

Histology of the heart revealed decompositional changes with signs of chronic oxygen insufficiency. Incomplete occlusion of the LAD coronary artery was noted based on connective tissue thickening of the intima. Pulmonary edema was noted based on

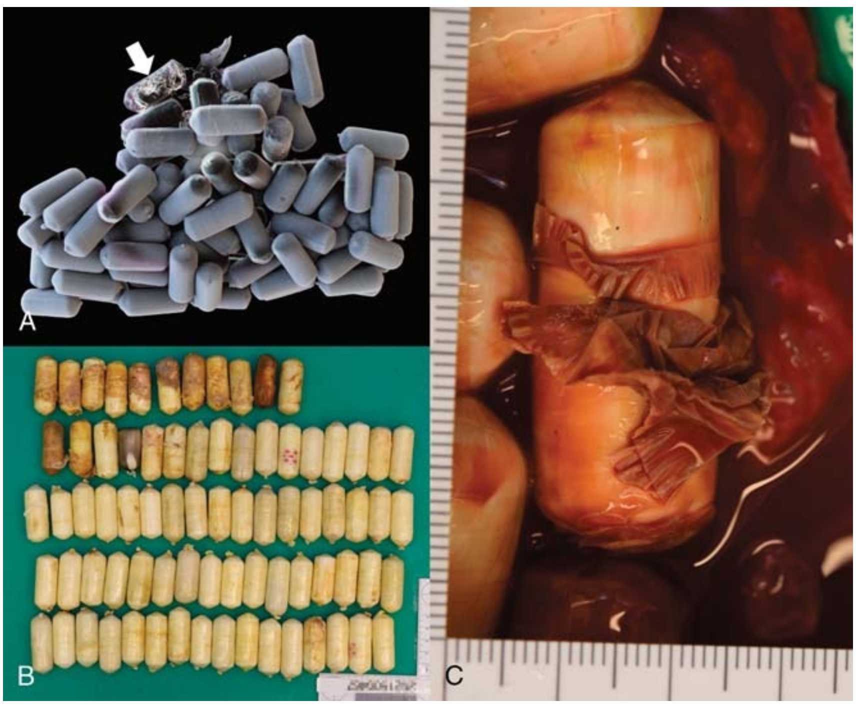

FIGURE 5. A, PMCT with cinematic rendering technique of the cocaine packs after removal during autopsy from the body. The white arrow indicates 1 of the disintegrated body packs with gas intrusion (in this decomposed case) and loose wrapping. The PMCT appearance is different from that of the other pristine packs. B, Autopsy photograph of the secured and cleaned evidence from the decedent's intestines. Distinct discoloration is noted in some of the packs and is likely attributable to leakage or disintegration. Note that the outer layer is poorly wrapped by adhesive tape, which tends to allow fluid intrusion into the packs, for example, by gastric content fluid. C, Macroscopic view of the gastric disintegrated adhesive tape located within the stomach (see Fig. 4C). Figure 5 can be viewed online in color at www.amjforensicmedicine.com.

increased fluid accumulation. Hypoxic nerve damage of the cerebellum was stated. Musculature showed that hemorrhage developed before death. The galea did not exhibit pathological findings.

Toxicology

Pharmacological and toxicological analysis detected very high concentrations of cocaine (4500 μ/kg), methylecgonine (14,000 μ/kg), and benzoylecgonine (22,000 μ/kg) in the musculature and a positive result for cocaine in the urine.

The pretesting in the urine was also positive for amphetamine, but liquid chromatography-mass spectrometry was negative for amphetamine, methamphetamine, "ecstasy", "eve", or any other amphetamine derivate. Loperamide was qualitatively detected. Other drugs, such as opiates, cannabis, methadone, barbiturate, and benzodiazepines, exhibited negative results. Ethyl alcohol was not detectable.

DISCUSSION

This forensic case presents unique postmortem imaging of a drug mule with fatal intoxication due to cocaine leakage on postmortem computed and MR tomography compared with autopsy. The leakage of the intracorporal cocaine packs was already detectable on PMCT due to the gas and fluid intrusion, with a nonhomogeneous appearance of the inside substance.[4] Postmortem computed tomography allowed the exact localization of the packs and determination of the amount of the entire payload. Because of the uniform and homogenous appearance of the packs, mechanically packed drug containers were correctly assumed.[3,5,20]

A study from 2006 describes an improved radiological detection with CT and MR imaging in living drug carriers; however, the problems of expense and accessibility for these methods are noted.[18] Computed tomography and PMCT are currently established methods for the detection of intracorporal drug containers.[4,5,14,21–26] However, MR is not the method of choice for living drug carriers because this examination is expensive and time-consuming and requires a compliant patient for the duration of the exam.[18,25,27] Compliance in living drug carriers is typically low in such scenarios. Algra et al[18] published rare MR images of intracorporal drug containers with a fast low-angle shot 2-dimensional out-of-phase/in-phase and T2 TSE sequences, all of which showed a homogenous hypointense signal of the drug containers in a living patient. This case report uniquely displays the appearance of cocaine drug containers in a postmortem case who died due to fatal cocaine intoxication. It confirms the described appearance of those intracorporal packs on PMMR and allows the assumption that MR is not the method of choice for imaging of drug carriers in general.[18] Exceptions may be contraindications for other imaging modalities, such as harmful radiation exposure, for example, in cases of pregnancy or very young patients. Magnetic resonance in living patients may pose an alternative for the detection of intracorporal drug containers if the patient is willing to undergo the exam and does not show signs of intoxication that would be considered an emergency situation.[18,27,28] Another future application for MR may be the scenario of predominant liquid drug packages carriers because they appear hyperintense on T2w sequences.[27,29] Ultrasound is another alternative for imaging such cases without radiation, but this technique has the drawback of being subjective and very dependent on the investigator performing the exam. In addition, a negative exam does not exclude intracorporal packs that may be disguised by superimposing structures, for example, gas.[25,30]

In this case, death did not occur within minutes based on the amount of ineffective metabolites of cocaine. The decompositional changes and the musculature sample obtained instead of blood did not allow further precision. The toxicological report stated that the dosage of cocaine intoxication was lethal.[31] Initial pretesting was positive for amphetamine but may have been a false positive due to decomposition, autolysis, and products of decay.

The other detected substance loperamide slows peristalsis and is frequently taken by drug carriers to impair the early excretion of the packs.[3,7] This analysis of loperamide indicates that the deceased individual was indeed a body packer. It still remains unclear why the body was moved after death. One may hypothesize that the body could have been moved by cartel members but, stunningly, without removing the precious internal payload.

CONCLUSIONS

This case provides a unique opportunity for imaging internal cocaine drug containers on PMCT and PMMR and determining the cause of death based on imaging.

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